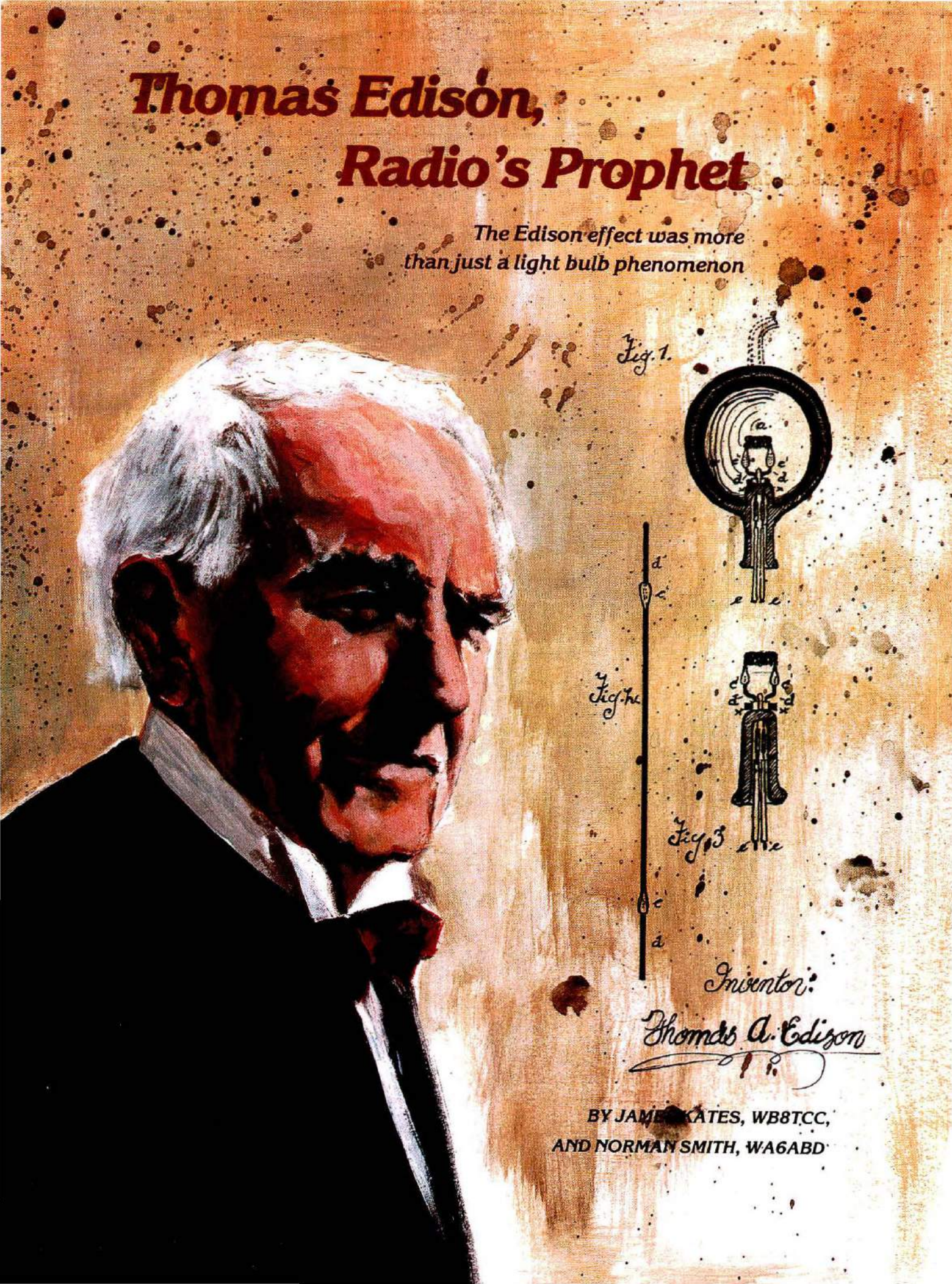
Thomas Edison, Radio's Prophet

The Edison effect was more than just a light bulb phenomenon



BY JAMES KATES, WB8TCC,
AND NORMAN SMITH, WA6ABD

In the latter part of April 1870, a 23-year-old telegraph operator turned inventor named Thomas Edison was ushered into the office of General Marshall Lefferts, the president of New York's Western Union Telegraph Company. Lefferts went straight to the point: he wanted patent rights to Edison's newest group of stock tickers.

"Well, young man," he said, "what do you think your improvements are worth? Let's settle up our bill."

Edison thought a moment. He felt his new inventions were worth at least $5,000 — but he was willing to settle for three. At last he replied.

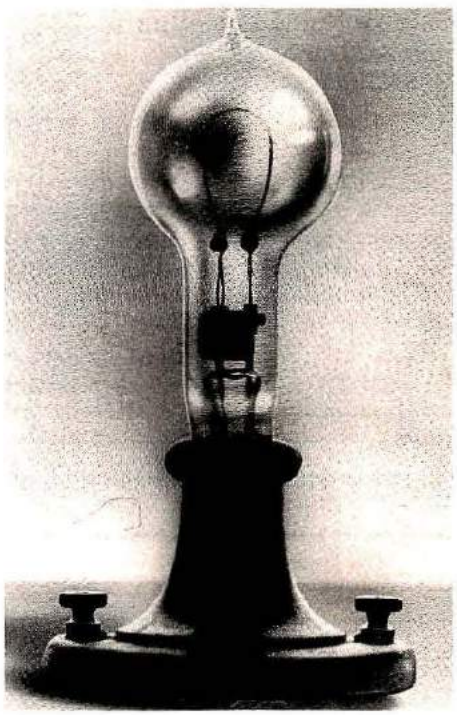
"Well, General, suppose you make me an offer," he said.

"How would forty thousand dollars strike you?"

At the mere mention of the sum Edison nearly fainted, but he pulled himself together and accepted the offer. Years later he would laugh at what happened next.

Three days later, Lefferts handed Edison a contract and a check for $40,000. The inventor was convinced he was being tricked. Forty thousand dollars! Skeptically he handed the check to a bank teller, who noticed that he had failed to endorse it. The teller handed the check back to Edison and tried to explain what was wrong, but Edison, having been almost totally deaf since the age of twelve, couldn't understand what the teller wanted; he had never before received a check. Sadly, he dropped out of line and trudged back to Western Union. So he *had* been tricked, after all. When he explained his problem to Lefferts, the General merely laughed and sent Edison back to the bank with a clerk. The clerk had Edison endorse the check and identify himself; the teller played his own little joke by paying Edison $40,000 in ten and twenty-dollar bills.

Edison had never cared much for money — only what he could buy with it. He invested every cent of the $40,000 in a four-story brick building at 10-12 Ward Street in Newark, hired a couple hundred men, and started manufacturing his "Universal" stock tickers for Western Union. While the hired men worked at the machines, the "old man" experimented in the back room of the shop and began to unlock the secrets of electricity.



Edison's basic incandescent electric lamp, patented January 27, 1880 (*photograph from The Bettman Archive*).

Most people associate Edison with the light bulb, the phonograph, and motion pictures — but *not* with radio. His name is often left out of radio history books or perhaps mentioned in passing. But during the years from 1875 to 1885, Edison pioneered some radio fundamentals which are still in use today — and the first of these discoveries was made at the lab in Newark.

The "Etheric Force" experiments

The "etheric" phenomenon, like most of Edison's radio contributions, was discovered while working on a more famous invention — in this case, a telegraph instrument that would send more than one message on a single wire.

On the night of June 2nd, 1875, Edison was experimenting with a new kind of multiple-telegraph apparatus: a *harmonic* telegraph. Alexander Graham Bell and other inventors had been working on the same kind of device, whereby a complicated system of wires, tuning forks, and relays allowed as many as eight messages to be sent simultaneously on one wire.

As Edison applied current to the electromagnet in the new circuit, he noticed a strange spark jumping from the magnet's iron core to a piece of iron directly above it. He'd seen these sparks before, and had always assumed them to be strictly electrical in nature. But, on this evening, he decided to investigate.

Edison's lab assistant, Charles Batchelor, kept the notebook on the first experiment. The sesssion lasted all night, but the test, titled "experiments to discover a new force," revealed nothing, and it was shelved in favor of work on the telegraph. The "new force," though, was not forgotten.

James Maxwell, the mathematical theorist, had published in 1873 his conclusion that electrical apparatus radiate some sort of electromagnetic waves which would obey the laws of light waves, but Edison is not believed to have read this work — he had little respect for theorists. Even in 1875, though, Edison could imagine uses for "etheric force," and he went to work to prove its existence.

On the night of November 22nd, Edison hooked up an electromagnet with its current supply rapidly switched on and off, as in a doorbell buzzer. Above it he fixed a bar of steel. Once more, the strange sparks jumped from the core of the

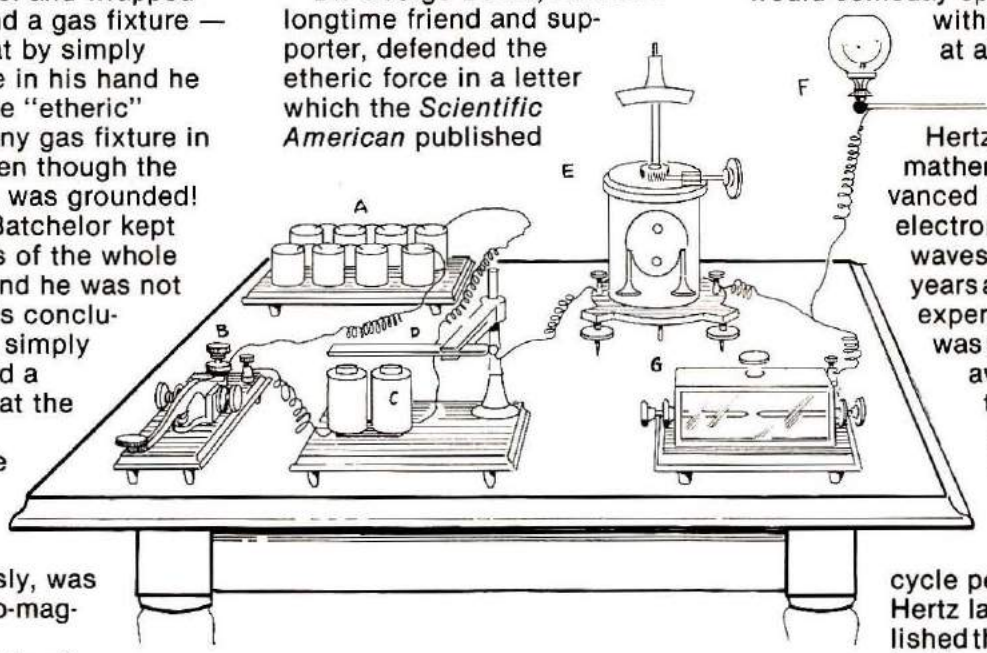
magnet. But they *wouldn't* obey the conventional properties of electricity. A gold-leaf electroscope, an instrument for measuring static charges, was brought near the spark with no results; the spark, when passed through a wire, wouldn't swing the galvanometer needle. It wouldn't even charge a Leyden jar! Edison hooked a wire to the bar of steel and wrapped the end around a gas fixture — and found that by simply holding a wire in his hand he could draw the "etheric" sparks from any gas fixture in the house, even though the entire system was grounded! Fortunately, Batchelor kept copious notes of the whole experiment, and he was not cautious in his conclusion. "This is simply wonderful, and a good proof that the cause of the spark is a true unknown force." The unknown force, obviously, was that of electro-magnetic waves.

The scientists of the day, however, didn't all share Batchelor's enthusiasm. While daily papers like the New York *Herald* called the etheric discovery the unlocking of a "great secret of nature," the *Scientific American* was more conservative, at first, proposing that perhaps etheric force was "electricity of a form between the static and galvanic kinds," and called the conclusion of a new force "rather hasty." Later when they weighed the data, they joined the daily papers and predicted that Edison would "rank with the most fortunate and eminent of scientific discoverers." And indeed he would — but not for his work in etheric force.

Though the *Scientific American* saw the uniqueness of the new force, many scientists, calling Edison a braggart and a fool, did not. One such scientist, in a letter to the *Scientific American*, flatly denied the existence of a new force, saying it *couldn't* be nonpolar and indifferent to ground, and proving his claims with mathematical theories. Edison ignored the man — he had disproven theories before.

Dr. George Beard, Edison's longtime friend and supporter, defended the etheric force in a letter which the *Scientific American* published on January 22nd, 1876. Calling the nature of the force "of admirable clearness," Dr. Beard supported Edison's idea that the force was "radiant . . . somewhere between light and heat on the one hand and magnetism and electricity on the other, with some features of all these forces."

Edison hardly needed Dr. Beard's support; he had always ignored his critics and would continue to do so for the next fifty years. He continued experimenting with the new force, using it to send messages as far as 75 miles on uninsulated wire. The critics were still unconvinced. "As etheric force is assumed not to require insulation," one of them wrote, "if we place its wires upon poles we shall save merely 40 insulators at 12 cents apiece to the mile, or $4.80. This certainly is not practical value." Little did this adversary of Edison's imagine that the etheric force would someday span the globe without any wires at all.

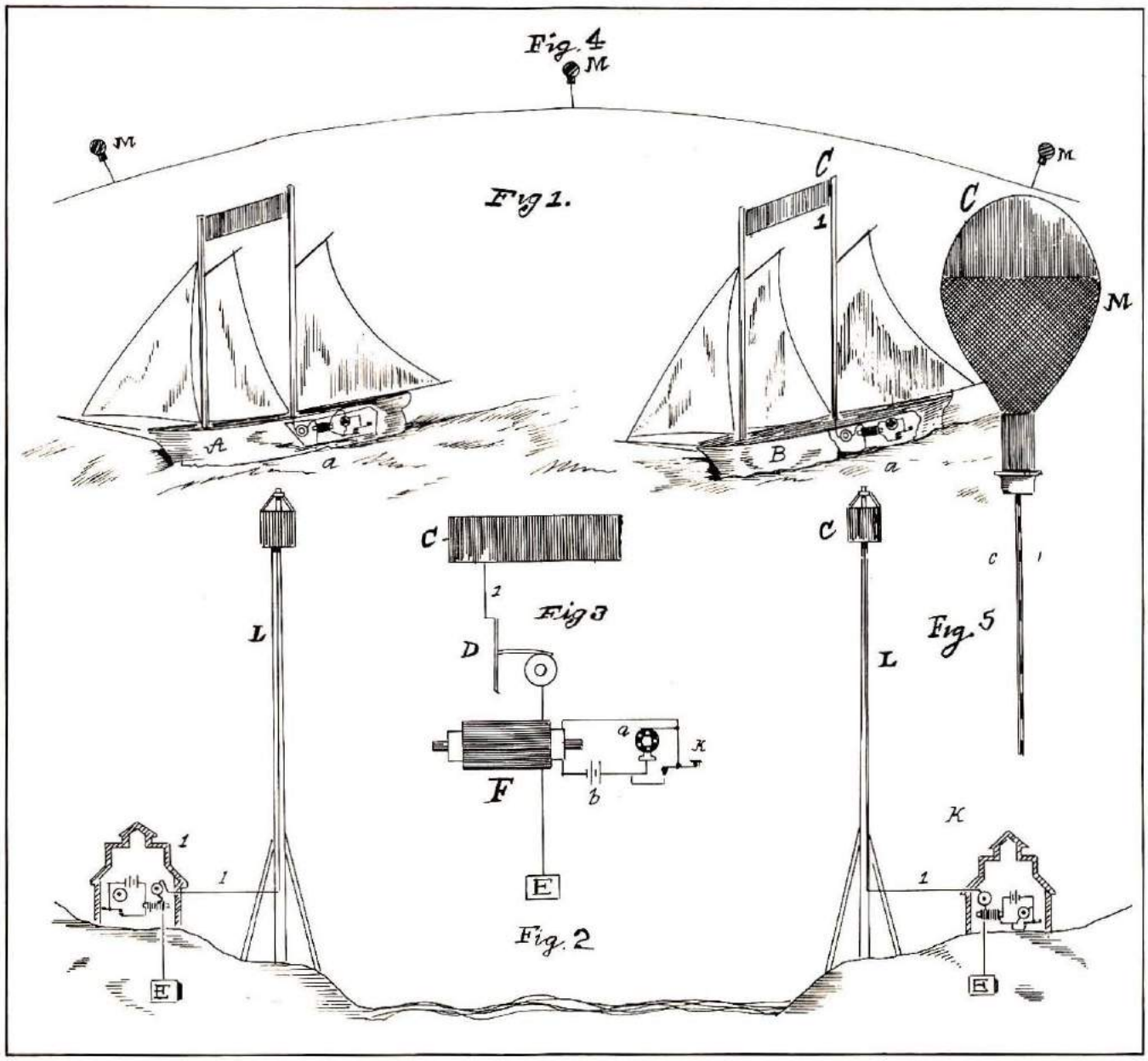


The apparatus Edison used to investigate the "etheric force" in his laboratory. Note that the circuit through the key, **B**, the pair of coils, **C**, and the batteries, **A**, has no electrical connection to the bar, **D**, suspended above the coils. The bar is connected to a gold-leaf electroscope **E**, a spark gap, **G**, and the whole system is "grounded" to a gas pipe, **F**. The etheric force induced in the bar and whatever it was connected to could be made to appear as sparks in any part of the system, including the gas pipes in other parts of the building or the whole city! (*Drawing retouched from the original of December 25, 1875, with permission of Scientific American.*)

Heinrich Rudolph Hertz, the brilliant mathematician, advanced his theory of electromagnetic waves in 1887, 12 years after Edison's experiments. Hertz was subsequently awarded the title of "father of the wireless," and his name is used today to mean one cycle per second. Hertz later established the mathematical basis for waves that Edison could never have dreamed of. Still, the fact remains: Thomas Edison discovered electromagnetic waves, and had he not been diverted by more pressing work in stock tickers, telegraphy, and later in phonograph, telephone, and the electric light, he might have sent signals across the Atlantic years before Marconi.

Telephone and microphone experiments

Perhaps the skepticism first associated with the telephone is best illustrated by this account from a Boston newspaper of 1865: "A man has been arrested in New York for attempting to extort funds from ignorant and superstitious people by exhibiting a device which he says will convey the

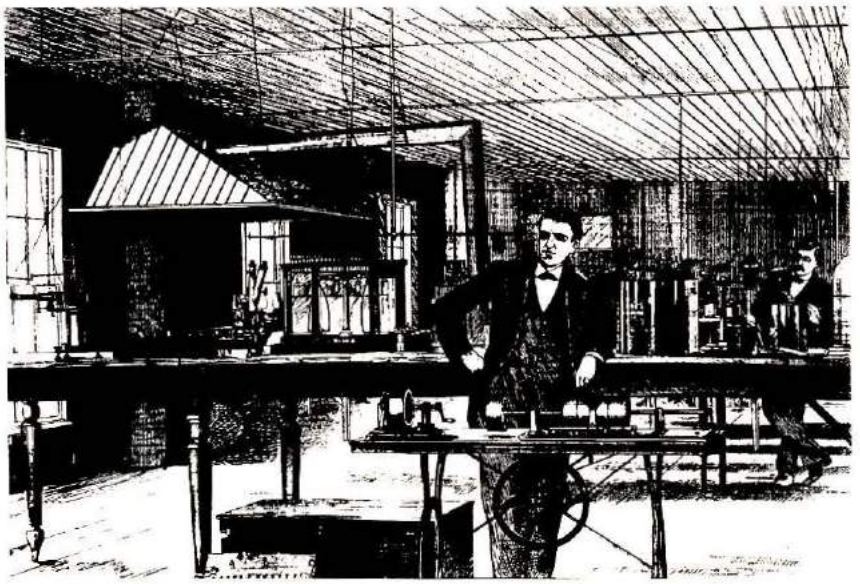


Edison's wireless telegraphy system was described in the *Scientific American* for January 16, 1892. His **Fig. 1** inset shows the apparatus used in ships, **Fig. 2** for land stations. **Fig. 3** is a close-up of the system itself wherein **C** is the so-called condensing surface (we would call it a top-loaded antenna), **D** is Edison's electromotograph receiver (earphone), **F** is an induction coil, and **a** is a rotary breaker-point device to interrupt the current from a battery, **K** is a normally closed key, and **E** is earth ground. His **Fig. 4**, at the top, represents the idea that the "etheric force" would travel beyond the horizon, following the curvature of the earth. (*Drawing retouched from the original, with permission of Scientific American.*)

human voice any distance over metallic wires. Well-informed people know that it is impossible to transmit the human voice over wires, and that, were it possible to do so, the thing would be of no practical value." Alexander Graham Bell astounded the world with his telephone only eleven years later.

Bell's instrument, which became known as a *magneto* telephone, was largely a curiosity at first. The same device was used both as a transmitter and receiver. A coil of fine wire was fixed around a rod-shaped permanent magnet, and a diaphragm rested in front of the two. When the device was spoken into, the vibrations of the diaphragm in the magnetic field induced a tiny current of electricity in the coil, which traveled to the other instrument. This instrument's coil acted as an electromagnet when current flowed through it, vibrating the diaphragm.

Bell demonstrated his telephone over wires as long as 100 miles, but the instrument's inherent problem was that it generated its own current, which wasn't strong enough to overcome the resistance of the telegraph wires. One reporter theorized that Bell's magnetic



An 1878 woodcut depicting Edison's laboratory and machine shop at Menlo Park, New Jersey, where he was working on the phonograph and the telephone (*from The Bettman Archive*).

telephone would never work on a wire more than 200 miles long. Western Union, sensing a possible gold mine in the telephone business, put Edison under contract to improve Bell's instrument.

About the same time he signed the telephone contract, Edison began looking for a new laboratory site. He was now relatively famous, and tired of being disturbed by reporters, scientists, and curious laymen who dropped by the lab at all hours. In 1876, he purchased several lots at Menlo Park, New Jersey, a quiet country hamlet 20 miles southwest of New York City. He built a house, a library, and a two-story clapboard building where he and his staff could do nothing but invent things, free from the city's distractions.

Once he was settled at Menlo Park, Edison made hundreds of experimental telephone transmitters to test his theories. He knew the problem with Bell's — its lack of ability to generate a strong electronic current — and felt he could solve the problem by placing a battery in the circuit and using a Bell receiver along with a transmitter that would fluctuate the battery current in response to the voice's vibrations. He tried hundreds of substances in the transmitter — water, strips of paper, even mercury — but finally hit on carbon. In his search for the ideal telephone transmitter, Edison invented the carbon microphone.

Edison's microphone of April 1st, 1877, was similar in principle to the modern carbon mike. He attached a button of carbon to the back of a large diaphragm. As the diaphragm moved, it moved the button, which vibrated against several pieces of charcoal held in a line behind it on strips of spring steel. One wire was attached to the rear piece of charcoal, and the other to the carbon button.

One wire from the microphone was attached directly to a terminal of Bell's receiver, and the other wire ran through a battery to the other terminal. When spoken into, the microphone varied its resistance in direct proportion to the strength of the voice, and allowed more or less current to flow to the receiver. The resulting receiver volume was several times that of Bell's magneto system — and Edison had invented the device that would give radio its voice.

Soon after, Edison applied for his first patent covering the use of "lampblack" (carbon) in a telephone transmitter. The new carbon transmitter had several times the power of the old magneto type, and it was rugged, cheap, and dependable. Western Union made quick use of it. The Western Union system, however, was still using Bell's magneto receiver; Bell, on the other hand, was using the carbon transmitter, and realized he couldn't have a practical system without it. A fiery court battle looked inevitable. In Edison's own words: "They infringed on my transmitter and we infringed on their receiver, and there we were cutting each other's throats. Well, of course this could not go on forever, and consolidation had to come."

Western Union and the Bell Telephone Company finally agreed to arbitration, but Edison felt that the Bell people were asking for more than their share. He cabled Western Union: "Do not accept terms of consolidation. I will invent new receiver and send it over." It took him less than three months.

Edison's new receiver relied on the *electromotograph* principle, which he had discovered several years earlier at Newark. He had discovered that should he run a wire from one pole of a battery to a piece of metal, and the other to a flat piece of chalk, he could draw the metal across the chalk with practically no friction whatsoever! Should the battery be disconnected, the normal friction returned.

In Edison's "electrochemical" receiver, a small cylinder of chalk was rotated by a hand crank at the side of the receiver, and a metal rod rested on top of the chalk. The other end of the rod was attached to a large diaphragm at the front of the instrument. When an electrical impulse entered the receiver, the friction between the rod and the chalk lessened,

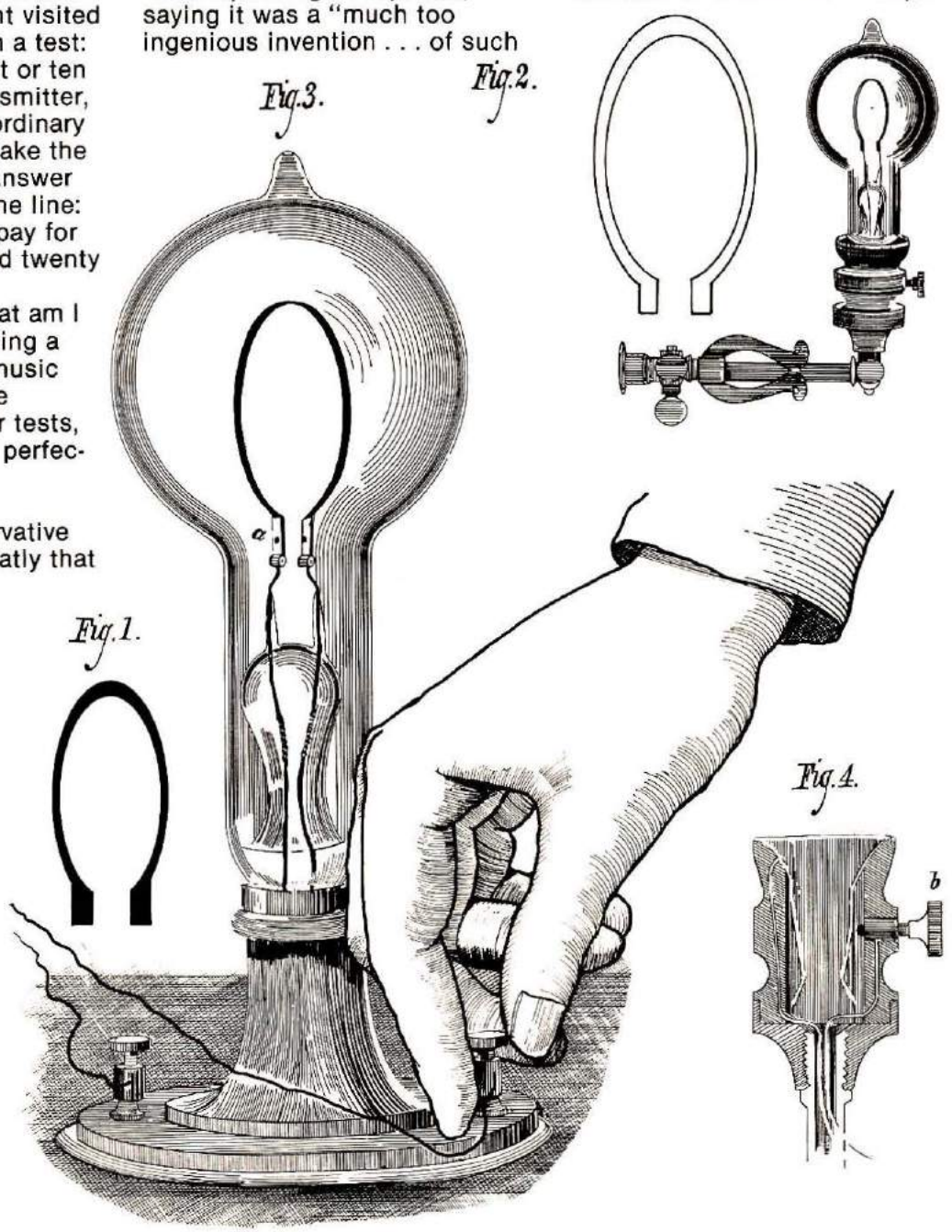
which pushed the diaphragm outward proportionately. When combined with the carbon transmitter, the result was a telephone of startling efficiency — and it was 100 per cent Edison's! The motograph receiver produced ample volume to fill a room with sound. Indeed, it was the first electrochemical loudspeaker ever made. And the carbon transmitter was so sensitive that one could carry on a telephone conversation while standing several feet away from the instrument. One *Scientific American* correspondent visited Menlo Park during such a test:

"Standing some eight or ten feet away from the transmitter, Mr. Edison said, in an ordinary tone of voice, 'Do you take the *Scientific American*?' Answer from the other end of the line: 'I do.' Q. 'What do you pay for it?' A. 'Three dollars and twenty cents a year.' Q. (while crumpling a paper) 'What am I doing now?' A. 'Crumpling a paper.' Then followed music from a music box of the smallest size, and other tests, showing the wonderful perfection and power of the instrument."

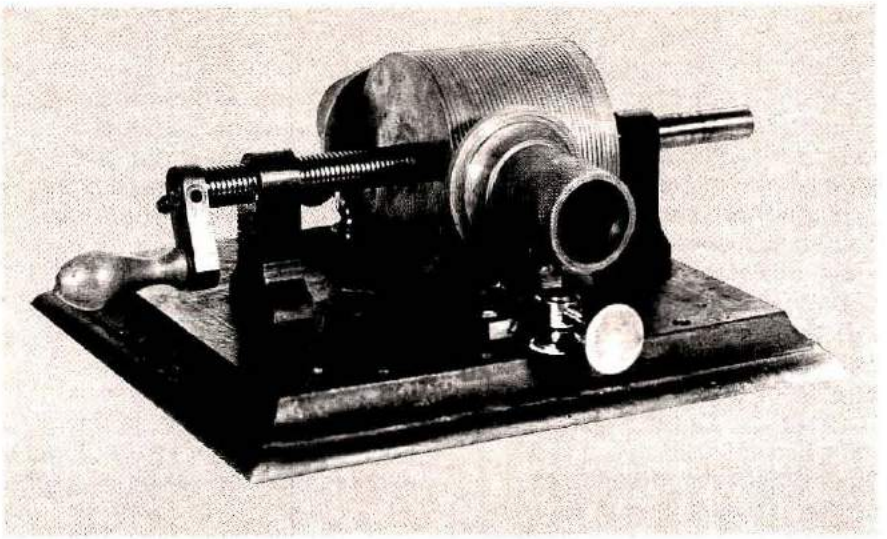
The ordinarily conservative London *Times* stated flatly that Edison's receiver was "far superior to Bell's." In time, though, the motograph receiver proved *too* superior. The telephone was not an instrument for public exhibit; it was an instrument for private conversation, and, after the court battles ended, the Bell receiver/Edison transmitter combination proved ideal for this purpose. George Bernard Shaw, the playwright, worked briefly for the Edison Electric Company in Great Britain, and later commented about the "loud speaking" telephone, saying it was a "much too ingenious invention . . . of such stentorian efficiency that it bellowed your most private communications all over the house." And so the motograph receiver never came into general use, but it did give Western Union a little more leverage in the negotiations when it finally settled its legal differences with Bell in 1879.

The electric light and the Edison Effect

Edison's most famous invention, of course, is the electric light. The years of work and tens of thousands of exper-



The electric lamp, which occupied so much of Edison's time in the laboratory. This reproduction of the original drawing shows the carbon filament, **Fig. 1**, and the cardboard from which it was made, **Fig. 2**. **Fig. 3** shows the completed lamp and its base, and a hand for size comparison. The inset above the hand is a wall fixture for the new lamp — it draws heavily on the architecture of gas lamps of the era. **Fig. 4** is the lamp socket — the lamp is turned on or off by means of the thumb screw, **b**, which makes or breaks contact with a metal strip in the socket. (*From the January 10, 1880, issue of Scientific American, with permission.*)



Edison's original phonograph, patented in 1878 (*photograph from The Bettman Archive*).

iments he devoted to the perfection of a practical light bulb and its subsequent power generation and distribution systems earned him not only fame and fortune — in the process he was to discover a little-publicized phenomenon that would prove to be the foundation of later electronics.

After completion of his telephone work in the summer of 1878, Edison was badly in need of a rest. When Edison's friend, Professor George F. Barker, invited him to join a group of scientists traveling to Rawlins, Wyoming, to view a total solar eclipse, he gladly accepted. The party set out in July; Edison carried his *microtasimeter*, an instrument for measuring very slight changes in temperature. Like several of his recent inventions, the tasimeter proved to work *too* well — the heat of the sun's corona drove the needle right off the scale!

Edison enjoyed the trip immensely, and he spent hours talking over his inventions with the other scientists. But one thing in particular captured his imagination: they were talking about electric lighting. Edison could hardly wait to return to Menlo Park. *Here* was a brand-new challenge!

On the return trip, Edison and Barker stopped near Yosemite, where teams of miners extracted iron ore from the ground by hand.

"Barky," said Edison, "that work would be easier if we could harness Yosemite's falls and turn the power into electricity. Someday our great waterfalls will make electric power enough to light every home and factory in the world, and we won't have to bother with gas anymore."

"You ought to meet Bill Wallace, a friend of mine," said Barker. "He's trying to make an electric lamp."

"Let's go!" said Edison.

Edison visited Wallace in September. The Connecticut inventor was working on an *arc light* — in which two rods of carbon were brought close together, and a high voltage jumped across the gap. Already, some streets and factories were lighted by the arcs, but their harsh, blinding light, short life, and noxious odor made them impractical for home use. Edison saw no future in the arcs — he needed a lamp which would provide a soft, glare-free light. Still, he was impressed by Wallace's operation. "I saw for the first time everything in practical operation," he said later, "and I saw that the thing had not gone so far but that I had a chance." Edison ran from the row of glaring arc lights to the generator and back again. "Mr. Edison was enraptured," said Wallace. "He sprawled over the table with the simplicity of a child and made all kinds of calculations."

At last Edison finished his tour — now there was work of his own to be done.

"Wallace," he said, "I believe I can beat you in making electric lights. I don't think you're working in the right direction. I believe that to chain electric current we will have to divide it, so the light won't be so hot and blinding."

"Divide electric current!" Wallace laughed. "Why that's impossible!"

"I believe it can be done," Edison stated calmly.

From then on, Edison was hooked — and he returned to Menlo Park more determined than ever. Edison was rarely overconfident, but he predicted that he'd have a practical light within six weeks. In reality, it was to take him about 14 months — the most trying project of his career. "I was never discouraged," he said later, "but I can't say the same for other people who were working with me."

Edison and his assistants tried hundreds of filaments; they performed over nine thousand separate experiments. They first experimented with rare metals like platinum and rhodium, but later tried everything imaginable: grasses, palm leaves, bamboo — even a hair from Charles Batchelor's beard!

The early experiments with metals were largely unsuccessful, although Edison *did* patent an early platinum lamp. "Often," recalled Francis Jehl, a young lab assistant, "I saw Edison, as he reached a crucial point in an experiment, dart his fingers through his bushy hair distractedly, or throw away a half-smoked cigar and absent-mindedly take another out of a vest pocket to tear off the tip with a savage bite. No one can guess how many platinum

lamps were tested during these experiments, or how many times he sat there past midnight poring over them."

One morning Edison turned to Jehl. "Francis," he said, "have we got a pump around here?" Jehl brought the pump, and Edison mounted a platinum spiral inside a bulb and pumped out the air. The same filament that had produced five candlepower in air produced twenty five in the vacuum! Edison figured that the higher the vacuum he could obtain, the longer his lamps would burn. He assigned Ludwig Boehm, the glassblower, to work on an improved version of the "Sprengel" pump, in which a column of mercury running through a tube literally pushed the air out of the bulb. Boehm delivered the model — a large board covered with tubing. At last, Edison had the vacuum he needed.

Even in the vacuum, though, the platinum filaments were unsatisfactory. To burn brightly, they had to be brought near their melting point, and usually they disintegrated.

One night, Edison sat alone in the laboratory, the flickering gas jets casting dim shadows on his face. Why was it, he thought, that he couldn't seem to find the answer? His backers had advanced him $100,000, but now that money was gone and there wouldn't be any more. The days and nights of the "insomnia squad" just hadn't paid off, and the men were beginning to lose confidence. There *had* to be a solution.

As Edison sat thinking, he toyed with a mortar full of carbon particles at his side. He rolled them between his fingers into a filament. Carbon, he thought — that hadn't worked either; it had always broken apart as the current was applied to it. But then he sat up with a start.

"But that was before we had the vacuum bulb!"

For the next several weeks, Edison and the staff worked with carbonized filaments. For each of the tests, the filament — be it paper, hair, or even a strip of grass — was rolled in the carbon particles, shaped into a horseshoe, and baked in the furnace. Then came the most difficult step: getting the delicate filament into place without shattering it. Usually it would crumble into pieces as it was being inserted in the bulb.

"Bosh," Edison would say. "Well, boys, let's try again." As his assistants prepared another filament, Edison examined the old one under a microscope. His method was one of careful observation, and every flaw was noted in the ledger. One day he sent for Batchelor.

"Hey Batch," he said, "get me a spool of thread. I've got an idea."

Edison cut a short length of thread and formed it into a hairpin shape; Batchelor carbonized it in the furnace. At first the filaments broke, but finally, on October 19, 1879, they managed to seal one inside a bulb and pump out the air. Edison hit the switch.

The new light glowed immediately. Its light was soft, not harsh or glaring, and it didn't flicker. Edison and his assistants sat watching, waiting for irregularities — but there were none. As word of the new lamp spread around the little village to the boarding house, the men filed by the lamp and stared in awe. A lamp lasting more than a few minutes seemed unusual; in fact, they had become accustomed to failure. At first they were silent, but then they laughed, patted Edison on the back and bet each other cigars on how long the lamp would burn. Eventually, though, most of them tired of staring at the

Fig.1

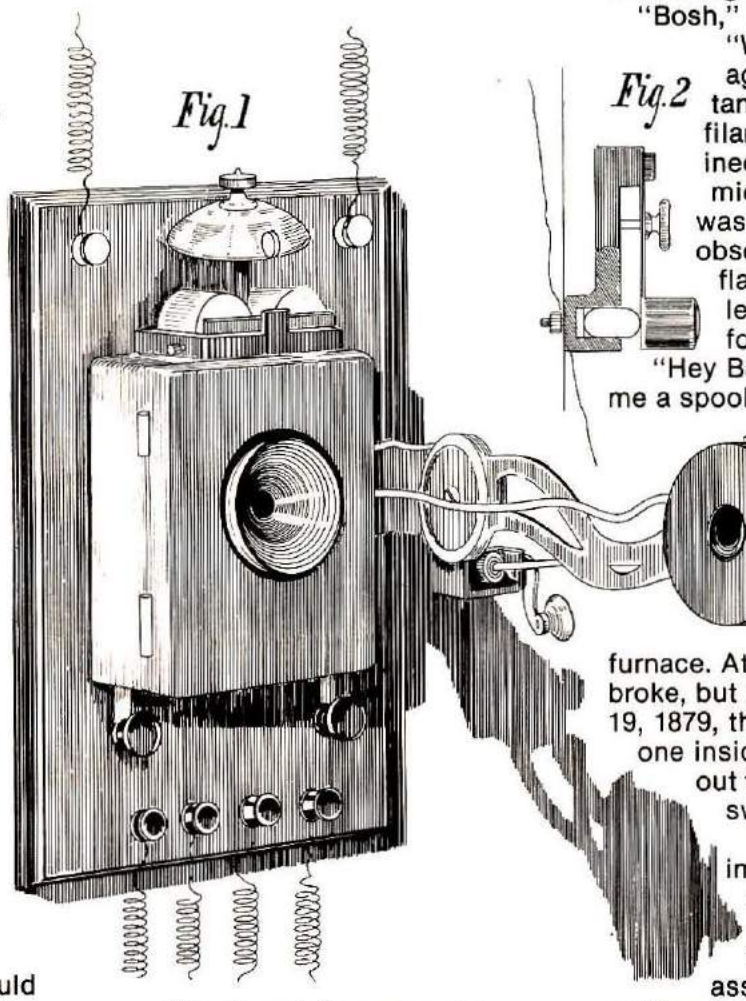


Fig.2

Edison's new telephone as depicted in the July 6, 1878, *Scientific American*. Although the electrical parts changed, the style remained for many years. The microphone (a carbon-button type) is mounted on the wooden box. The jointed arm on the right carries the "receiver," which was a marvelously miniaturized version of his electromotograph earphone. To use the receiver, a person had to turn the little crank (under the arm, right) by hand. This turned a moistened chalk cylinder, which reacted to electric current by producing more or less friction against a stationary contact. This difference in friction was turned into sound waves by means of a diaphragm. The arm was hinged to allow folding out of the way when not in use. (*Drawing retouched from the original by permission of Scientific American.*)

Thomas Edison and Dr. Irving Langmuir discussing the vacuum tube at the General Electric Research Laboratory (*photograph from The Bettman Archive*).

bulb and went back to the boarding house. Only Edison and Jehl remained. The lamp burned through the night and into the next without a flaw.

Between one and two o'clock on the afternoon of October 21st, Edison was satisfied that he had found the answer. He yielded to temptation, and forced more and more current into the lamp, until it expired without warning. Edison recalled the incident: "We sat and watched it with anxiety growing into elation. I was sure that if this rather crude experimental lamp would burn forty-five hours, I could make a lamp that would burn hundreds of hours, and even up to a thousand."

At last the secret had been revealed. Edison was pleased, though not overjoyed — there was much work ahead. The bulb itself was only one link in an immense chain Edison had envisioned from the start of his experiments: an advanced power generation and distribution system that would make gas lighting obsolete.

When Edison announced a public demonstration of his electric lighting system for New Year's eve, his assistants thought he was insane. There were hundreds of devices — switches, fuses, sockets and the like — that had to be invented within 60 days.

Edison finally settled on a filament of carbonized cardboard, and forty of these were made up for the system and installed on Menlo Park's gas fixtures. The dynamo also needed improvement. Edison had previously used batteries for his electric light tests, but now he needed a system that would power dozens of lamps reliably. He made dozens of tests, and readied his first practical dynamo, the "Long-Legged Mary Ann," only days before the demonstration.

As the first of the excursion trains rolled into Menlo Park on New Year's eve, Edison threw the master switch, and forty lamps glowed in unison. The crowd aboard the car was one of New York's finest. The people, dressed in their most elegant party clothes, gasped at the sight and rushed into the lab. Soon, trains, carriages, and wagons arrived, carrying hundreds of curious people. Edison threw open the doors and invited everyone in. "Some of them behaved very badly," wrote a reporter for the New York *Sun*. "Eight electric lamps were stolen . . . a malicious rascal was caught trying to destroy the current and put out the lights by putting a piece of metal across the exposed connecting wires . . . Even kind, patient, and good-natured Edison was angry . . . and perhaps his ill humor was slightly helped by the knowledge that an inebriated pseudo-scientist was in the crowd villifying him and belittling the results achieved."

Edison, dressed in an old gray shirt, flannel coat and chalk-stained trousers, stood by the generator and caught quips of conversation — most people mistook him for a coal stoker. Occasionally someone would recognize him, and at the cry of "There's Edison!" people crowded around the famous inventor.

"Many of them had come in," reported a New York newspaper, "with the expectation of seeing a dignified, elegantly dressed person, and were much surprised to find him a simple young man attired in the homeliest manner, using for his explanations not high-sounding, technical terms, but

the plainest and simplest language."

The New Year's exhibit was a great success in the eyes of the public, but some critics were skeptical of the new system. On January 4th, 1880, the New York *Times* encouraged "sensible people not to throw away their gas stock or rush into speculation on electric stock." Just the same, the investor's confidence in "The Wizard of Menlo Park" was overwhelming, and shares of stock in the new Edison Electric Light Company floated at $100 soared as high as $4,000.

It was during the improvements on the electric light that Edison discovered a phenomenon which is still made use of in today's radio equipment. Just as he had with the "etheric force," Edison stumbled upon it by accident; and his keen sense of observation led to a new discovery which was to become the basis of modern electronics.

Edison's carbonized-filament lamps were remarkably efficient, but they had one overriding problem: after they had burned a few hours, they left a dark film on the inner surface of the bulb.

A lab assistant, William Hammer, is said to have pointed out that there was a small line of glass — a "ghost", as they called it later — that didn't become blackened. It appeared almost as if the positive leg of the filament had cast a shadow across the inside of the bulb. Edison tested the film, and his hunch was confirmed — the material was carbon. Apparently, the filament was giving off some sort of negative particles, which hit the inside surface of the bulb everywhere except directly behind the positive leg of the filament, which was soaking them up!

To test his theory, Edison sealed a wire inside the bulb between the positive and negative legs of the filament. When he connected the other end of the wire to the negative side of the battery, he got nothing; but when he connected it to the positive, the resulting current flow drove the needle of his sensitive galvanometer right off the scale. Later, at the Philadelphia Exhibition, Edison demonstrated that this current he pulled out of a vacuum was strong enough to operate a telegraph sounder!

What Edison had discovered, in effect, was an inexhaustible source of free electrons. He filed for a patent on the "Edison effect" on November 15th, 1883.

"I have discovered," he stated in his application, "that if a conducting substance is interposed . . . within the globe of an incandescent electric lamp, and said conducting substance is connected outside of the lamp with one terminal, preferably the positive one . . . a portion of the current will . . . pass through the shunt circuit thus formed, which shunt includes a portion of the vacuous space within the lamp."

Edison, of course, couldn't foresee the uses the "Edison effect" was to have in radio, but he did search for an application. His patent, which was granted October 21st, 1884, covered the use of the "Edison effect" bulb as a governor to control the output of electric generators. The effort failed, due to the difficulty of maintaining a high vacuum within the bulbs, and Edison, who was preoccupied with the expansion of his electric company, "didn't have time to continue the experiment."

In 1882, Sir John Ambrose Fleming, who was then an advisor to the Edison Electric Light Company in London, also experimented with the "Edison effect." Six years later, he discovered that the Edison-effect bulb could be used to rectify alternating current.

Beginning in 1899, Fleming worked as an advisor to the Marconi Wireless Company. A few years later, Marconi and Fleming were experimenting with a "coherer" — a primitive form of radio detector in which silver particles were enclosed in a glass tube. As a high-frequency radio wave coursed through the coherer, its silver particles aligned and effectively rectified the signal, but there was one drawback: the silver particles stayed in place even after the signal was gone, and the wireless operator had to "reset" the coherer by tapping it with a hammer!

One evening Fleming was experimenting with a new chemical detector when it occurred to him: why not try the lamps? Needless to say, the "lamps" worked perfectly. "The missing link in wireless was found," said Fleming, recalling the experiment, "and it was an electric lamp!"

The wireless telegraphy patent

In 1885, Guglielmo Marconi was eleven years old. Hertz was not to advance his theory of electromagnetic waves for two years. The longest telephone line in the country was less than 300 miles. And Thomas Edison filed for a patent on a system of wireless telegraphy.

Edison's system was based on induction, not "etheric force," but it was a remarkable prophecy of wireless to come. The system actually sent messages over short distances, and was the first to use transmitting towers. Marconi's system, some ten years later, was to use the high-frequency Hertzian waves, of course, but the similarity between the two is striking.

Edison's device consisted of a telegraph key hooked to a sort of electric buzzer that generated a rough electric spark. The spark was amplified by an induction coil, and sent to a tall antenna, where it leapt through the "ether" into a receiving antenna, through a motograph receiver, and into the ground. In his patent application, Edison predicted how radio was to be used:

Edison experimenting with the first motion picture machine — another of his fields of experimentation — in 1905 (*photograph from The Bettman Archive*).

"I have discovered," he stated, "that if sufficient elevation be obtained to overcome the curvature of the earth's surface and to reduce to a minimum the earth's absorption, electric telegraphy or signalling between distant points may be carried on by induction, without the use of wires connecting such distant points."

Edison sold his patent, #465,971, to Marconi in 1903, for what he termed "a song."

The wireless patent was put to use one year later, when it was used to send telegrams from moving trains on the Lehigh Valley Railroad. The rails acted as a ground, and the messages were sent via an antenna on the roof of the car to a telegraph wire running alongside the track. Though the messages were sent through only a few feet of air, this was probably the first practical application of "wireless" ever devised.

Edison did no further work with his "wireless," as he was diverted by other projects. But his conceptions of antennas, towers, "absorption," and the like were remarkable mirror-images of radio to come. A dozen years later, Edison remarked to a friend that he thought wireless signalling across the Atlantic might be possible someday, but he didn't know when. Marconi did just that in 1901, and Edison asked to meet the man "who had the monumental audacity to attempt and succeed in jumping an electric wave across the Atlantic."

Marconi recalled Edison's comments on his achievement: "I shall never forget Mr. Edison's laconic comment, 'If Marconi says it's true, it's true.' Nothing ever pleased me as these words."

Edison touched radio only indirectly; had he been born 20 years later, his best-known work would probably have been in that field. He pioneered in radio while the sending of messages through the air was still considered folly, and the critics gave him their worst. Fortunately, Edison had the foresight to turn his deaf ear on them. His was a method of trial and error, inexhaustible curiousity, and careful observation.

"In another age and time," said Henry Ford, Edison's lifelong friend, "each of Edison's inventions would have been considered either as unique scientific discoveries or as scientific toys. The older scientists made their discoveries as things of themselves and were so far away from the daily workaday world that they would have lost standing had they even suggested the possibility that their studies could have any commercial application. Then Edison came along — a greater scientist than any of them but without being bound by the old scientific traditions. He was a scientist, but also he was a man of extraordinary common sense. It was a new combination."

Certainly Edison's discovery of "etheric force" accords him a place in radio history; but when we add the microphone, the "wireless" experiments, and the "Edison effect" to the picture, his place in the development of radio becomes strikingly important.

"Discovery," Edison said, "is not invention, and I dislike to see the two words confounded. A discovery is more or less in the nature of an accident. A man walks along the road intending to catch the train. On the way his foot kicks against something and he sees a gold bracelet embedded in the dust. He has discovered that — certainly not invented it. He did not set out to find a bracelet, yet the value is just as great." So it was that Edison stumbled upon some of radio's most essential principles; and when, at the time, he couldn't find application for them, he blamed no one but himself. "My experience," he said, "is that for every problem the Lord has made He has also made a solution. If you and I can't find the solution, then let's honestly admit that you and I are damned fools, but why blame it on the Lord and say He created something impossible?"

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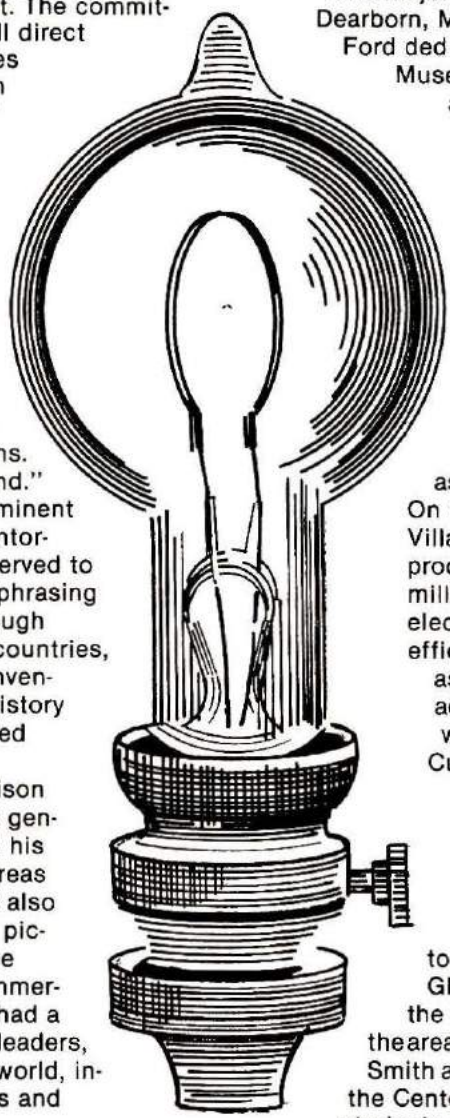
HRH

International Centennial of Light Planned for 1979

A year-long "Centennial of Light," an international celebration to commemorate the 100th anniversary of Thomas Edison's invention of the incandescent electric light bulb on October 21, 1879, was announced by Walker L. Cisler, chairman and chief executive officer of the Thomas Alva Edison Foundation, headquartered in Detroit, Michigan.

At the same time, Cisler announced that Robert I. Smith, chairman of New Jersey's Public Service Electric and Gas Company would head the International Committee for the Centennial of Light. The committee, made up of industrial leaders, will direct and coordinate the numerous activities planned for the centennial. "The main objective of the Centennial of Light," according to Committee Chairman Smith, "is to regenerate enthusiasm for invention and innovation. Clearly, Edison typified this enthusiasm for scientific and technological advancement as a service to mankind's quality of life. During the next year," Smith continued, "we will endeavor to instill in today's generation and future generations a recognition that there are solutions to today's problems. They only need to be sought and found."

Smith said that Edison is the pre-eminent example of the highly principled inventor-businessman, whose developments served to benefit civilization and freedom. Paraphrasing an Edison biographer, he said, "Although Edison led no armies, conquered no countries, enslaved no people, his life and his inventions have influenced the course of history more than any other person in recorded civilization."



Besides the incandescent bulb, Edison invented the entire system of electric generation and distribution which carried his "magic" first to cities, then to rural areas and, finally, throughout the world. He also invented the phonograph, the motion picture camera, and equipment that made telephone and telegraph systems commercially practical. His scientific genius had a direct bearing, according to industry leaders, on the growth of today's electronics world, including radio, modern motion pictures and television.

Since the light bulb is only one of more than 1,000 inventions patented by Edison, numerous and diverse organizations plan to participate in the Centennial celebration. Among those already planning special programs, events and activities for the Centennial of Light are the American Association for the Advancement of Science; the Smithsonian Institution of History and Technology; the United States Park Service; the Edison National Historic Site in West Orange, New Jersey, the site of Edison's research laboratory; and Menlo Park, New Jersey, the city in which Edison conducted his successful experiments with the incandescent lamp. Also, the New Jersey Historical Commission; Fort Myers, Florida, the site of Edison's winter home and former site of his "Fort Meyers Lab"; the Electric Power Research Insititute; the Edison Electric Institute; and Rutgers University, which is initiating a 20-year project to organize and publish all of Edison's scientific papers.

In addition, numerous corporations in the electronics industry, both here and abroad, will celebrate the Centennial of Light to honor the man whose genius was the source of their corporate technologies.

One major focus of Centennial activities will be Dearborn, Michigan, where 50 years ago Henry Ford dedicated Greenfield Village and the Ford Museum to American values and ingenuity, and to the man he considered the greatest genius the world has ever known.

To create the full effect, Ford removed the 82-year-old inventor's first laboratory board-by-board and nail-by-nail from its original site in Menlo Park. Ford was so particular about details that he even transplanted the actual earth from the building's front yard. Upon first seeing the reconstructed laboratory, Edison wryly remarked, "Wonderful, only our floor was never as clean as this."

On October 29, 1929, at the Greenfield Village site, Edison re-enacted the entire process of what is called the "miracle of the millenium," the invention of a long-lasting electric light that was safe, practical, and efficient. He was assisted by Francis Jehl, as he had been 50 years before. In addition to Ford, other dignitaries present were President Herbert Hoover, Madame Curie, George Eastman, Harvey Firestone, and Cyrus Eaton.

Another center of activity will be West Orange, New Jersey, where Edison lived and worked for many years. The National Park Service now maintains the site and conducts tours of the laboratory buildings and Glenmont, Edison's home. Plans call for the inviting of a number of dignitaries to the area and for a series of special celebrations. Smith also announced that major elements of the Centennial of Light are designed for students and educators. Symposiums will bring selected high school students and teachers to Florida's Disneyworld in February, and university students and professors to San Francisco, in April.

Furthermore, science fairs will be encouraged in elementary and high schools throughout the country. Educational materials and scholarship programs will emphasize the need to encourage young people to pursue scientific knowledge. Other plans include special films, television and radio programs, traveling exhibits, displays, lecturers, and parades.

For more information, contact George Shea, International Committee, Centennial of Light, Thomas Alva Edison Foundation, P.O. Box 1310, Greenwich, Connecticut 06830.